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Technical note

Measurement of bonding strength of pine, kapur and meranti wood species as function of their surface quality

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ABSTRACT

The objective of this experimental study was to evaluate bonding strength of specimens from widely used three species, pine (*Pinus strobus*), kapur (*Dryobalanops* spp.) and meranti (*Shorea* spp.) as they were sanded with different grits of sandpapers. Surface quality of control samples and those sanded with 80, 100 and 240 grit sandpapers was determined using a stylus type equipment. Control samples of both hardwood species resulted in less smoother surface values when they were sanded with 80 grit sandpaper. Rougher surface quality of the samples had higher bonding values as compared to those of control specimens as well as those sanded with 100 and 240 grits. Based on the findings in this work, the stylus method can have a potential to evaluate surface roughness of these specimens to have a better understanding of overall bonding quality of such species so that they can be used more effectively for different applications.

1. Introduction

Wood products have been used for countless applications where their bonding strength plays an important role. Density, grain orientation, defects, surface quality, amount of adhesive and pressure are some of the both raw material and manufacturing parameters influencing an effective bonding quality of the members. It is important to evaluate bonding strength of wood so that different species can be used efficiently during their service life without having any possible failure. There are studies investigating bonding strength of various species [1–3]. Gupta et al. determined influence of defects including knots on shear strength of Douglas fir and found that knots did not significantly influence shear strength of the samples [4]. In another work, bonding strength of various tropical species glued together using poly vinyl acetate (PVAc) adhesive was studied, and determined that extractive content of the samples had adverse effect on their bonding quality [5]. Serrano also investigated shear strength of wood as non-homogeneous material employing finite analysis technique [6].

Surface quality in the form of roughness of wood and wood products affects many properties for an effective utilization. Wood is an hygroscopic material changing its properties with fluctuation in climate conditions of surrounding environment. Its surface quality also changes due to above parameters and sanding would be one of the most commonly used processes to improve its surface quality. It is fact that specimens sanded with larger grit size sandpaper will create rougher surface characteristics. In a previous study, surface quality and shear strength of tangentially and radially glued samples of Japanese sugi, Japanese hinoki, Japanese hiba and Japanese karamatsu species were investigated [7]. In this work, it was found that both surfaces of all three types of specimens sanded with 80-grit sandpaper resulted in higher bonding strength values than those of control and other sanded samples [7]. Several studies also used stylus method to quantify surface quality of different species to relate to their bonding

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strength [8–10]. Burdurlu et al. investigated shear strength of Calabrin pine specimens as function of their surface roughness employing stylus technique [11]. Adhesive shear strength between wood veneer and particleboard wood studied by Hiziroglu and Rabiej [2]. They determined that increasing adhesive rate on the surface of the samples improved their overall bonding quality [2].

Currently there is no accepted standard method to determine surface roughness of wood and wood products. Although there are several methods including laser, light sectioning, pneumatic technique and stylus type profilometers. Stylus type of equipment has been used successfully in many experimental research projects to quantify surface roughness of wood and wood based products [12,13]. It provides objective and quantitative numerical values about the surface with a clear profile [14,15].

All three species considered in this work are extensively used for production of cabinet, furniture and kitchen units. Most of the physical and mechanical properties of these species have been studied. However, there is very limited information on bonding strength quality of samples from these species as function of their surface quality. Therefore, the main objective of this work was to determine surface roughness of samples sanded with three grit sizes of sandpaper and glued together so that bonding strength of the specimens can be evaluated. It is expected that findings from this work would provide some fundamental information on bonding strength of these species so that they can be used with better efficiency for various assembly applications.

2. Materials and methods

100 mm by 50 mm by 20 mm defect free samples of three species were cut from long strips supplied by a local manufacturer. All of the samples were conditioned in a room with a temperature of 20 °C and a relative humidity of 65% until they reach equilibrium moisture content of 13%. A total of defect free 40 pairs of specimens were prepared for each species. Density of each sample was also determined by weighing and measuring their dimensions at accuracy levels of 0.01 g and 0.1 mm, respectively. Samples were finished using light pressure for 50 strokes on 80-, 100- and 240-grit sandpapers. In the next step, five measurements with 12 mm tracing length across the grain orientation were taken from the surface of each sample employing stylus type profilometer, Mitutoyo Surftest – SJ-301. Tracing speed, stylus force and stylus radius tip of the profilometer are 0.5 mm/s, 4 mN and 5 μm, respectively. Fig. 1 illustrates profilometer used in the work. The stylus of the equipment was randomly positioned and measurements were taken perpendicular to the grain orientation of each sample. There are numerous roughness parameters which can be used to characterize a surface. Average roughness (R_a) is the most popular one among the others and has been successfully employed to evaluate surface quality of wood and wood based panels in different past studies [7,14]. Average roughness (R_a) was also used in this work and its definition can be found in detail in literature [14,15]. Every 100 measurements, accuracy of the stylus was checked on a standard plate having and average R_a value of 3.05 μm.

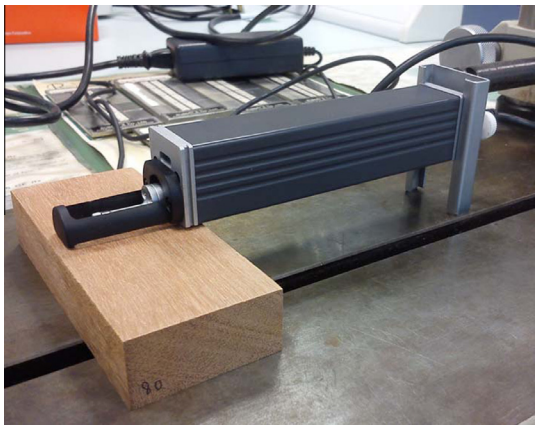

Fig. 1. Surface roughness profilometer.

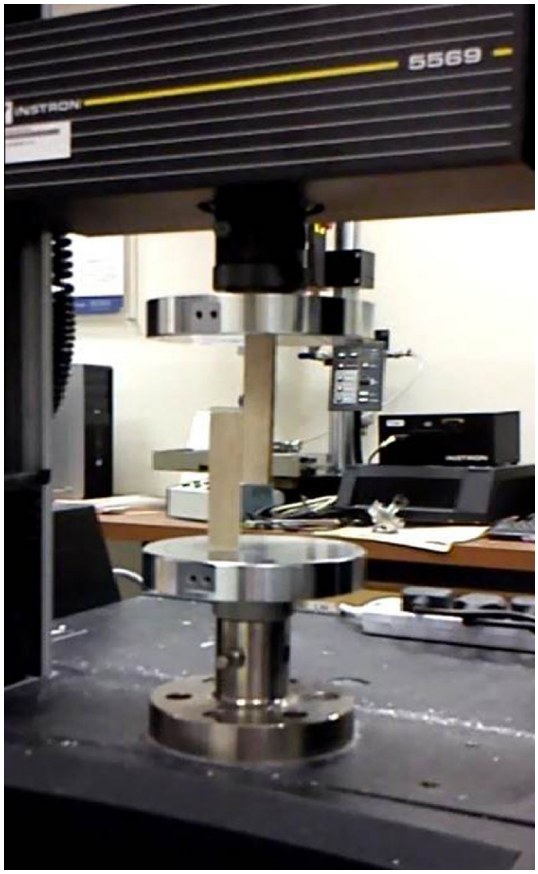

Fig. 2. Shear strength test set-up.

After surface roughness measurements of the specimens were completed, they were bonded together in pairs using polyvinyl acetate (PVAc) adhesive. Adhesive was applied to each side of the pairs at a speed rate of 200 g/m^2 and compressed for 30 min using a pressure of 0.2 MPa.